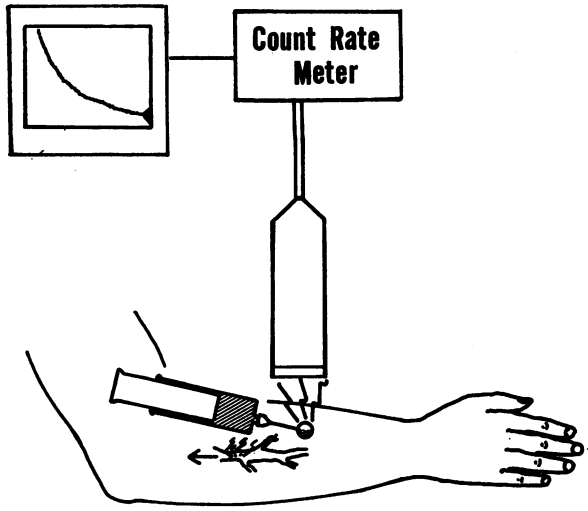

Figure 2.—Tissue clearance method for measurement of peripheral blood flow.

veys of this kind in animal preparations have already been undertaken, but only a few corresponding measurements of circulation in the human in shock have been reported. In general, only those methods should be considered that measure a relatively specific blood flow or perfusion rate and are not traumatic for the already debilitated patient.

Venous occlusion plethysmography is probably the least traumatic method available for measuring blood flow. The recently developed electrocapacitance plethysmograph (Figure 1) provides the additional advantage of leaving the part under study in its normal state: skin temperature, evaporation of sweat from the part and counter pressure on the tissue are unchanged. In addition, the practical advantages of simplicity and ease of handling make this technique the best approach of measurement of blood flow in the extremities.

Blood flow through skin and muscle can easily be separated by an extension of this method. The rate of volume increases after venous occlusion is diminished by pressure applied over the local area. With 25 to 35 mm of mercury in a cuff between the skin and the electrocapacitance screens, blood flow decreases to a level that represents perfusion of deep tissue only. This method has not yet been applied to patients in shock.

The so-called tissue clearance method would also be applied to the evaluation of peripheral circulation in shock (Figure 2). The rate of removal of a small ionic solute from a local injection site in tissue fluid mirrors the rate at which similar molecules are removed from tissues, and provides an estimate of the efficiency of local blood flow. The method involves no trauma, can be directed at a specific tissue, and promises information concerning the physiologically important nutritional flow through the periphery.

Renal Morphology in Patients With Shock

RICHARD E. HOROWITZ, M.D.*

In reviewing the postmortem findings in patients who died on the Shock Ward in 1963, it was found that the most common kidney alteration was the classical "shock kidney," grossly characterized by a pale cortex and a dark red medulla. Microscopically, such kidneys had relatively anemic cortices and pronounced congestion of the vasa recta. Such changes occurred in virtually all patients in shock.

Acute tubular necrosis, also ineptly called lower nephron nephrosis, is thought to be an invariable component of shock. The criteria used for this diagnosis are: (1) patchy necrosis of convoluted tubules; (2) fragmentation of tubular basement membranes; (3) focal acute inflammation; and (4) red cell or heme casts (Figure 3). These changes were observed in only seven of 38 patients with shock and were severe in only three. No cases of renal cortical necrosis were observed, although fibrin thrombi in the glomerular capillaries, the early

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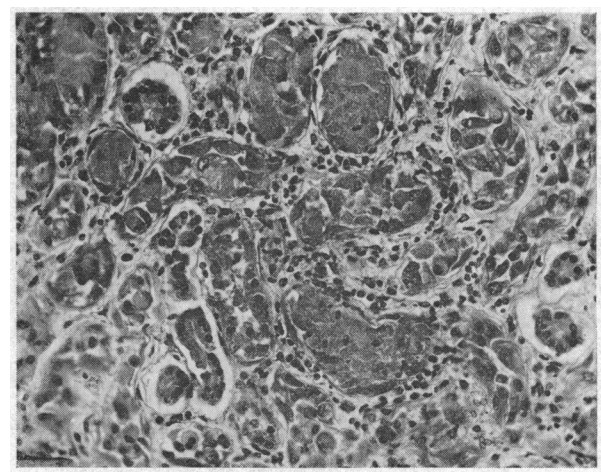

Figure 3.—Acute necrosis of renal tubules. Note necrotic tubular cells, acute inflammation and fragmentation of tubular basement membranes. Hematoxylin and eosin stain, ×250.

manifestation of cortical necrosis, were seen in one patient.

The largest single group of patients, nine of a total of 38, had clinical features of shock during, or shortly after, abdominal surgical operation, and these had the highest incidence of acute tubular necrosis (four of the nine patients). No case of clinical shock of less than 12 hours' duration had tubular necrosis. Conversely, tubular necrosis was absent in three patients who were clinically in shock for 48 hours or more. There was no correlation between histological necrosis of tubules and the blood urea nitrogen concentration. Some patients with near normal blood urea nitrogen (BUN) had tubular necrosis, while other patients with BUN over 100 mg per 100 ml had normal kidneys. There was also no obvious relationship between urine flow and acute tubular necrosis.

These observations indicate that the incidence of acute tubular necrosis as a complication of shock is considerably less common than we anticipated and that it is remarkably unrelated to urine flow or blood urea concentration. The data would support the concept that renal failure and oliguria are related to decreased renal perfusion, in part attributable to intrarenal (Trueta) shunts.

The Peripheral Circulation During Shock

HAROLD D. GREEN, M.D.*

Studies were carried out on the comparative behavior of the resistance vessels in skin, kidney, cerebrum and skeletal muscle in dogs during hypotension and shock. Blood flow (electromagnetic-meter) and effective perfusion pressure were measured: (1) during local hypotension produced by graded compressions of the arterial supply to the organ; (2) during systemic hypotension produced by graded withdrawal of blood in steps of 5 ml per kg of body weight until mean arterial pressure was reduced to 35 to 40 mm of mercury; (3) during hypotension maintained at 35±5 mm of mercury for 1.0 to 2.5 hours by additional withdrawals of blood as required; and (4) during the "irreversible" phase of shock (Chart 7). "Irreversible" shock occurred when the blood pressure fell further unless blood was reinfused. When the "uptake" of blood reached 5 ml per kg, all remaining blood was returned to the animal. Arterial pressure rose and usually approached the control level, but then declined progressively until the animal died.

In the cerebrum, kidney and skeletal muscle, blood flow was usually maintained at near normal levels by local autoregulation in the face of declining perfusion pressure. However, vasoconstriction occurred in kidney and skeletal muscle, overpowered the autoregulation, and severely reduced flow in these organs as well as in the skin. In skeletal muscle, vasoconstriction was mediated by neural pathways, whereas both humoral and neurogenic mechanisms operated in the skin. Cerebral blood flow was maintained even though systemic arterial pressure decreased.

Vasodilation occurred in skeletal muscle and the cerebral bed during development of "irreversibility." This vasodilation in skeletal muscle may be an unfortunate decompensatory change accounting for the final progression of shock.

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Reports from the USC Shock Research Unit on Practical Aspects of Management of the Critically Ill

Miss Martha Kawabe, R.N., Head Nurse in the Shock Research Unit, discussed clinical management and research on the critically ill. She described the emergence of nursing in the computer age and indicated the remarkable efficiency and accuracy obtained with the aid of the computer in measuring arterial pressure, venous pressure, pulse rate, heart rate, urine output and other vital functions. The possibility of using the computer to regulate the rate of infusions and to initiate automatic heart pacing was reviewed. The implications of such medical technologic changes as they affect the training of nursing personnel were apparent.

David G. Stadelman, a mathematician who formerly served as principal programer of the Shock Research Unit, discussed the interphase of computer technology and medicine and the feasibility of installing a computer in a hospital environment to assist in the management of patients. He demonstrated the potential value of automatic plotting and logging to relieve nursing and medical staffs of the time-consuming tasks that interrupt more direct care of the patient. The tremendous potential of improving understanding of the patient's condition by automatic presentation of information